

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

**EP 0 745 868 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:  
**17.04.2002 Bulletin 2002/16**

(51) Int Cl.7: **G01S 7/486**

(21) Application number: **96303505.0**

(22) Date of filing: **17.05.1996**

(54) **Temperature compensated APD detector bias and transimpedance amplifier circuitry for laser range finders**

Temperaturkompensierte Vorspannungsschaltung für einen Detektor mit Lawinenphotodiode und Transimpedanzverstärker für Laserentfernungsmesser

Circuit de polarisation pour un détecteur à photodiode à avalanche compensé en température et amplificateur d'adaptation d'impédance pour télémètres à laser

(84) Designated Contracting States:  
**CH DE ES FR GB IT LI**

• **Kuehn, Robert A.**  
**El Segundo, California 90245 (US)**

(30) Priority: **02.06.1995 US 460483**

(74) Representative: **Jackson, Richard Eric et al**  
**Carpmaels & Ransford,**  
**43 Bloomsbury Square**  
**London WC1A 2RA (GB)**

(43) Date of publication of application:  
**04.12.1996 Bulletin 1996/49**

(73) Proprietor: **Raytheon Company**  
**El Segundo, California 90245 (US)**

(56) References cited:  
**DE-A- 4 328 553** **GB-A- 2 181 832**  
**US-A- 4 001 614** **US-A- 4 415 803**  
**US-A- 4 464 048** **US-A- 4 882 482**

(72) Inventors:  
• **Nourcier, Charles E., Jr.**  
**Lakewood, California 90712 (US)**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

[0001] The subject invention relates to laser range finder circuitry and, more particularly, to improved detector bias and transimpedance amplifier circuitry particularly useful with APD laser range finder receivers.

#### 2. Description of Related Art

[0002] Prior art avalanche photodiode detectors and laser range finders incorporating such detectors are known from US-A-4464048, US-A-4001614 and DE-A-4328553.

[0003] Present laser range finder receivers rely on photodiodes for detection of target returns. There are two major categories of receiver photodiodes for detection: the acceptor intrinsic donor ("PIN") diode, and the avalanche photodiode ("APD"). Either type of device can be based on indium gallium arsenide ("InGaAs") or germanium technology. The PIN diode is the most commonly used, but requires a signal of 60 nanowatts to 100 nanowatts for a 99% probability of detection. Uncooled APD receivers currently in use are capable of 99% detection with a signal of about 10 nanowatts. Because the greater sensitivity of the APD detectors translates into a greater maximum system range, they are preferred for fabrication of a universal device applicable to a family of eye-safe laser range finders.

[0004] Current APD receivers rely on a bias network that instantaneously steps the bias voltage down by some number of volts. This instantaneous step causes the transimpedance amplifier ("TIA"), which amplifies the detector signal, to saturate. The recovery from this effect can take as long as a microsecond. The saturation condition is due to current flowing through the parasitic capacitor across the detector (approximately 1 pF) during the step voltage transition. Under these conditions a diode must be used in the TIA circuit in order to clamp the input of the TIA. This diode adds parasitic capacitance on the order of 0.8 pF, which reduces circuit sensitivity and significantly increases the cost of the detector/ preamplifier (TIA).

[0005] Present APD receivers are optimized at room temperature and, therefore, are significantly suboptimal at other operating temperatures. System sensitivity over temperature thus cannot be guaranteed. A number of components are also required for testing the frequency response of present APD amplifiers.

### OBJECTS AND SUMMARY OF THE INVENTION

[0006] It is therefore an object of the invention to improve laser systems;

[0007] It is another object to improve laser range find-

er circuitry;

[0008] It is another object of the invention to improve detector bias and transimpedance amplifier circuitry applicable to laser range finders;

5 [0009] It is another object to increase sensitivity of laser range finder systems; and

[0010] It is another object to significantly improve sensitivity of laser range finder systems over temperature ranges such as -40 to +85°C while decreasing cost.

10 [0011] According to the present invention, there is provided a laser range finder apparatus as claimed in claim 1 hereinafter.

[0012] Thus, the net effect of the invention is lower cost and significantly higher yield due to increased margin on sensitivity, as well as optimal system performance over operating temperature extremes.

### BRIEF DESCRIPTION OF THE DRAWING

20 [0013] The objects and features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages, may best be understood by reference to the following description, taken in connection with the accompanying drawing.

25 [0014] FIG. 1 is an electrical circuit diagram of an APD bias circuit and transimpedance amplifier according to the preferred embodiment.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 [0015] As shown in FIG. 1, the preferred embodiment of the invention includes an APD bias circuit 311, an APD detector 315, and a transimpedance amplifier circuit 317. While the detector 315 is preferably an APD device, other detector devices, such as PINs, can be used in various embodiments according to the invention.

35 [0016] With respect to the APD bias circuit 311,  $I_{UP}$  and  $I_{DN}$  signals are applied to the inputs of respective inverter amplifiers  $A_{b1}$ ,  $A_{b2}$ , for example, by a system microcontroller (not shown). The output of the inverter  $A_{b1}$  is applied to the gate of a first bias circuit field effect transistor (FET)  $Q_{b1}$  and to the input of a second inverter amplifier  $A_{b3}$ . The gate of the first bias circuit FET  $Q_{b1}$  is connected through a resistor  $R_{b1}$  to a reference voltage (+5 volts). The source of the first FET  $Q_{b1}$  is connected to ground, while its drain is connected to a first terminal of a resistor  $R_{b3}$ . The second terminal of the resistor  $R_{b3}$  is connected to a first terminal of a resistor  $R_{b2}$  and to the gate of a second bias circuit FET  $Q_{b2}$ . The second terminal of the resistor  $R_{b2}$  and the source of the second bias circuit FET  $Q_{b2}$  are connected in common to a 130-volt dc supply voltage. A zener diode  $Z_{b1}$  is connected in parallel with the resistor  $R_{b2}$ .

55 [0017] The drain of the second bias circuit FET  $Q_{b2}$  is

connected to a first terminal of a resistor  $R_{b4}$  whose second terminal is connected to the anode of a diode  $D_{b1}$  and to the drain of a third bias circuit FET  $Q_{b3}$ . The source of the third bias circuit FET  $Q_{b3}$  is connected to ground, while its gate is connected to one terminal of a resistor  $R_{b5}$  and to the output of the inverter amplifier  $A_{b3}$ . The second terminal of the resistor  $R_{b5}$  is connected to a 5-volt dc reference voltage.

**[0018]** The cathode of the diode  $D_{b1}$  is connected to a first terminal of a bias voltage storage capacitor  $C1$  and to the drain of a fourth bias circuit FET  $Q_{b4}$ , whose source is grounded. The gate of the fourth bias circuit FET  $Q_{b4}$  is connected to the output of the inverter amplifier  $A_{b2}$  and to one terminal of a resistor  $R_{b6}$  whose second terminal is connected to the 5-volt dc reference voltage.

**[0019]** The bias voltage storage capacitor  $C1$  has its first terminal further connected to one terminal of a resistor  $R1$  whose second terminal is connected to a shunt capacitor  $C2$  and to the cathode of the APD detector diode  $CR1$ . The second terminal of the capacitor  $C2$  is grounded. The anode of the APD diode  $CR1$  is connected to the anode of a PN diode  $CR3$  whose cathode is further connected to ground. An AC coupling capacitor  $C3$  connects the anode of the APD detector diode  $CR1$  to the input of the transimpedance amplifier 317.

**[0020]** The input to the transimpedance amplifier 317 comprises a node constituting the intersection of the first terminals of respective resistors  $R4$  and  $R5$ . The second terminal of the resistor  $R4$  is connected to the gate of a first FET  $Q1$ , whose source is connected to ground and whose drain is connected to the first terminal of a resistor  $R12$  and the emitter of an NPN transistor  $Q2$ . The second terminal of the resistor  $R12$  is connected to one terminal of a capacitor  $C5$  whose opposite terminal is grounded, as well as to the collector of a PNP transistor  $Q3$ .

**[0021]** The collector of the second transistor  $Q2$  is connected to the anode of a PN diode  $CR4$  and to the junction point of the second terminal of the resistor  $R5$  and the first terminal of a resistor  $R6$ . The cathode of the PN diode  $CR4$  is connected to one terminal of a capacitor  $C6$  whose second terminal is connected to the base of the transistor  $Q2$ . The base of the transistor  $Q2$  is further connected via a resistor  $R9$  to the second terminal of the resistor  $R12$  and to a resistor  $R8$  whose second terminal is connected to the 5-volt dc reference voltage.

**[0022]** The base of the third transistor  $Q3$  is connected to the second terminal of the resistor  $R5$ , which thus constitutes a feedback resistor from the output to the input of the amplifier 317. The emitter of the third transistor  $Q3$  constitutes the output of the transimpedance amplifier circuit 317 and is further connected to the first terminal of a resistor  $R11$ . The second terminal of the resistor  $R11$  is connected to the first terminal of a resistor  $R7$ , whose second terminal is connected to a -5-volt dc reference voltage. The first terminal of the resistor  $R7$  is

further connected to a first terminal of a capacitor  $C8$  and to the second terminal of the resistor  $R6$ . The second terminal of the capacitor  $C8$  is grounded. Examples of typical components for circuitry constructed according to the preferred embodiment are as follows:

TABLE

Resistances K( $\Omega$ )	Other Components
$R_{b1}$ - 2	$C1$ - 22 nF
$R_{b2}$ - 4.7	$C2$ - 10 pF
$R_{b3}$ - 100	$C3$ - 15 pF
$R_{b4}$ - 200	$C5$ - .01 $\mu$ F
$R_{b5}$ - 2	$C6$ - 10 nF
$R_{b6}$ - 2	$C8$ - .01 $\mu$ F
$R_{b7}$ - 200	$CR3$ - HP 5082
$R1$ - 3.3	$CR4$ - HP 5082
$R4$ - .02	$Q1$ - NEC71000MVC
$R5$ - 51	$Q2$ - 2N4957
$R6$ - 1	$Q3$ - 2N2857
$R7$ - .01	
$R8$ - .01	
$R9$ - 1.27	
$R10$ - 1	
$R11$ - 2.3	
$R12$ - .160	

**[0023]** The foregoing values are illustrative only and may be varied in various embodiments for optimal performance in various laser range finder systems.

**[0024]** In operation of the circuit of FIG. 1,  $I_{UP}$  and  $I_{DN}$  control signals are selectively applied, for example, by a microcontroller. The control signal  $I_{UP}$  turns on FET  $Q_{b2}$  by turning off FET  $Q_{b1}$ , causing the gate of the FET  $Q_{b2}$  to float up in voltage. The increase in voltage permits current to flow from the 130-volt source through the resistor  $R_{b4}$  and the diode  $D_{b1}$ , causing the voltage on the bias voltage storage capacitor  $C1$  to increase until such time as the  $I_{UP}$  control signal is turned off. The open collector type of logic gate is particularly designed to drive FETs such as FET  $Q_{b1}$ .

**[0025]** When the  $I_{UP}$  control signal is off, the FET  $Q_{b3}$  turns on, shorting the resistor  $R_{b4}$  to ground so as to drain off leakage current from FET  $Q_{b2}$  in order to prevent such current from further charging the capacitor  $C1$ . While  $I_{UP}$  is off, the diode  $D_{b1}$  serves to maintain the bias voltage held by the capacitor  $C1$ ; i.e., it prevents discharge of the capacitor voltage by current flow through the FET  $Q_{b3}$ . The bias voltage held by the capacitor  $C1$  may range from 30 volts to 90 volts and is determined by the length of time  $I_{UP}$  is "on" and the breakdown voltage of the APD 315.

**[0026]** Application of the  $I_{DN}$  control signal turns on the FET  $Q_{b4}$  and discharges the bias voltage storage capacitor  $C1$  to ground through the resistor  $R_{b7}$ . Both  $I_{UP}$  and  $I_{DN}$  are off when the circuitry is inactive.

**[0027]** Once the bias voltage storage capacitor C1 has been charged, the detector circuit 315 is biased for operation, for example, to detect a laser pulse return after firing of a laser. When the laser is initially fired, a large amount of energy is reflected or "back-scattered" back into the laser range finder optics, causing the TIA amplifier 317 to saturate. Accordingly, the diode CR3 is employed in the circuit to become forward biased by the increase in detector voltage and to dump the charge to ground; i.e., the diode CR3 comprises protection circuitry for accommodating initial overloads. The circuit provided by the capacitor C2 and the resistor R1 connected to the APD 315 limits the amount of energy which can be dumped through the diode CR3. After the diode CR3 stops conducting, the voltage on the capacitor C2 rapidly increases, via charging current flow through the capacitor C1 and the resistor R1.

**[0028]** The capacitor C3 is an AC coupling capacitor, which connects the detector circuit to the TIA 317. The TIA 317 itself may be viewed as a typical operational amplifier having a feedback resistor R5 connected between its output and inverting input which, in an illustrative embodiment, has a value of 51 K $\Omega$ .

**[0029]** In the preferred TIA amplifier 317 shown in FIG. 1, the current flowing into the R4-R5-C3 node is multiplied by the value of the feedback resistor R5, producing an output voltage at the emitter of the third transistor Q3. The FET Q1 has a "gm" parameter associated with it, which is basically a voltage-to-current converting factor. As current flows through the coupling capacitor C3, the gate voltage on the FET Q1 rises, causing more current flow through the FET Q1. The transistor Q2 tries to hold the drain of the FET Q1 at a constant voltage. Thus, as the FET Q1 "asks" for more current, the transistor Q2 turns off. As the transistor Q2 shuts off, in order to hold steady state, its collector voltage moves down, producing a voltage across the feedback resistor R5. For the selected value of R5 of 51 K $\Omega$ , this voltage ultimately equals 51 K $\Omega$  times the current flowing through the AC coupling capacitor C3. The transistor Q3 is a buffer-follower whose emitter voltage side is .7 below the voltage on its base (i.e., the voltage developed across the feedback resistor R5).

**[0030]** The TIA amplifier resistor R6 can be used to achieve a manufacturing advantage according to the preferred embodiment. The stability of the amplifier is a function of the open loop gain, which is determined by the "gm" of the FET Q1 and the value of the resistor R6. Thus, if gm changes, the value of R6 may be adjusted to compensate for it. Thus, in production, an entire wafer of FETs Q1 may be fabricated. After R6 is adjusted to get proper compensation for one of the FETs Q1 from the wafer, all devices on that wafer can be used with the same R6 value.

**[0031]** As to the remainder of the components, resistors R9 and R10 bias the transistor Q2 and set its operating point. The capacitor C6 makes the node an AC short circuit. The diode CR4 prevents circuit overload.

The resistors R7 and R11 are respectively used for power supply isolation and to bias the second transistor Q3.

**[0032]** The feedback resistor R5 determines the amount of transimpedance gain, i.e., current-to-voltage transfer. Whatever current goes through C3 x 51K equals the output voltage swing. The feedback resistor R5 further determines the ultimate bandwidth of the system. Lowering the value of R5 provides more bandwidth, enabling the system to operate with shorter laser pulses.

**[0033]** The detector 315 and TIA amplifier 317 are preferably formed as a hybrid circuit on a common substrate such as alumina. A temperature sensor 319 is mounted on the substrate next to the detector 315 and enables optimizing the receiver as a function of temperature. Thus, an associated microcontroller may continuously monitor and recalibrate the receiver as a function of temperature. The temperature sensor 319 may be a commercially available AD590 sensor wherein a reference voltage is applied to a first terminal +TS, producing a current at a second terminal -TS which is related to temperature. This current is converted to a voltage which enables an associated microcontroller to read the temperature of the detector 315.

**[0034]** The frequency response of the system of FIG. 1 is measured by illuminating the detector 315 with an unmodulated CW source and looking at the noise spectrum at the output TIA OUT of the amplifier 317. The noise spectrum will have a power envelope versus frequency that is characteristic of the detector/preamplifier frequency response. The frequency response of the amplifier will vary from part to part due to the "gm" parameter of the preferred NEC71000 GaAs FET. The feedback loop can compensate for this effect by adjusting the values of the resistors R5 and R6. This is an important cost savings because the select-in-test only occurs once for each lot-buy of the NEC71000 FET. Therefore, the value of the resistor R6 is selected on the first unit and is fixed for the balance of the production run. The value of the resistor R5 is not normally changed because it affects the amount of output voltage.

**[0035]** Another feature of this design is the addition of the temperature sensor 319 within the detector/preamplifier package. The optimum detector bias voltage can shift dramatically with temperature changes. The temperature sensor 319 allows the system to monitor this condition and self-calibrate the receiver operating parameters, such as receiver offset voltages, false alarm rate, and APD bias voltage. Essentially, the receiver can be optimized for performance over the entire operating temperature range.

**[0036]** The receiver sensitivity is optimized by increasing the APD bias voltage (this increases the APD gain) until the APD noise is larger than the electronics noise. Once the APD noise begins to dominate the electronics noise of the preamplifier 317, further increases in APD gain will reduce the system NEP (noise equivalent power). At low temperatures, the APD gain must be high in order to overcome the preamplifier noise. This is

due to low leakage currents within the APD at low temperatures. Under these conditions, the APD noise may not be larger than the preamplifier noise because of limitations in achievable APD gain. All of these effects can be optimized by monitoring the APD temperature along with self-calibrating electronics.

**[0037]** Those skilled in the art will appreciate that various adaptations and modifications of the just-described preferred embodiment can be configured without departing from the scope of the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

## Claims

### 1. Laser range finder apparatus comprising:

a photodiode detector (315) having a first terminal and a second output terminal;  
a charge storage device (C1) connected to the first terminal of said photodiode detector (315) for storing a detector bias voltage;  
a first circuit including a transistor switch ( $Q_{b4}$ ) connected to said charge storage device and responsive to a first control signal to discharge said charge storage device (C1);  
a second circuit for charging said charge storage device;

#### characterised in that:

said second circuit comprises a current source ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ), connected to said charge storage device, responsive to a second control signal to apply a charging current to said charge storage device such that said detector bias voltage is determined by the duration of said second control signal; and  
the laser range finder further includes a temperature sensing circuit (319) mounted in the vicinity of said photodiode detector (CR1) for monitoring the temperature in said vicinity and providing a signal indicative thereof.

2. The laser range finder apparatus of Claim 1 further including a transimpedance amplifier (317) having an input connected to said second output terminal and an output.

3. The laser range finder apparatus of Claim 1 wherein said current source ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) includes a first field effect transistor ( $Q_{b2}$ ) having a first terminal connected to a voltage source, said field effect transistor ( $Q_{b2}$ ) being switchable to cause supply of said charging current to said charge storage device (C1).

4. The laser range finder apparatus of Claim 3 wherein said current source ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) includes a second field effect transistor having a gate terminal connected to receive said second control signal and a first terminal connected through a resistance ( $R_{b3}$ ) to the gate of said first field effect transistor ( $Q_{b2}$ ).

5. The laser range finder apparatus of Claim 4 further including a third field effect transistor ( $Q_{b3}$ ) having a gate, an inverter ( $A_{b3}$ ) having an output connected to said gate, said inverter having an input connected to receive said second control signal, said third field effect transistor ( $Q_{b3}$ ) further having a first terminal connected to the anode of a diode ( $D_{b1}$ ) and a second terminal connected to ground, said diode ( $D_{b1}$ ) further having a cathode connected to said charge storage device (C1).

6. The laser range finder apparatus of Claim 1 further including an overload protection circuit including a diode (CR3) connected to said photodiode detector (CR1) and to ground.

7. The laser range finder apparatus of Claim 1 wherein said overload protection circuit further includes a resistor-capacitor network ( $R1$ ,  $C2$ ) having a connection to said photodiode detector (CR1) for limiting the amount of excess charge which can be dumped through said diode (CR3).

8. The laser range finder apparatus of Claim 2 wherein said transimpedance amplifier (317) applies a current-to-voltage transfer factor to a current at its input so as to produce a voltage at its output which is a multiple of said current.

9. The laser range finder apparatus of Claim 8 wherein said transimpedance amplifier (317) includes a field effect transistor ( $Q1$ ) and a first resistance ( $R6$ ) and has an open loop gain determined by a parameter "gm" of said field effect transistor ( $Q1$ ) and by the value of said first resistance ( $R6$ ); and wherein the value of said first resistance ( $R6$ ) is adjusted to compensate for variations in the parameter "gm" in order to maintain a desired open loop gain.

10. The laser range finder apparatus of Claim 8 wherein said transimpedance amplifier 317 further includes a feedback resistance ( $R5$ ) whose value is said multiple.

11. The laser range finder apparatus of Claim 8 wherein said feedback resistance ( $R5$ ) is adjustable to increase the bandwidth of said apparatus.

12. The laser range finder apparatus of Claim 1 wherein said photodiode detector (CR1) comprises an ava-

lanche photodiode.

## Patentansprüche

### 1. Laserentfernungsmößvorrichtung mit:

einem Photodiodendetektor (315), der einen ersten Anschluß und einen zweiten Ausgangsanschluß aufweist;

einer Ladungsspeichervorrichtung (C1), die mit dem ersten Anschluß des Photodiodendetektors (315) zum Speichern einer Detektorvorspannung verbunden ist;

einer ersten Schaltung, die einen Transistorschalter ( $Q_{b4}$ ) aufweist, der mit der Ladungsspeichervorrichtung verbunden ist und auf ein erstes Steuersignal anspricht, um die Ladungsspeichervorrichtung (C1) zu entladen;

einer zweiten Schaltung zum Laden der Ladungsspeichervorrichtung;

**dadurch gekennzeichnet, daß**

die zweite Schaltung eine Stromquelle ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) aufweist, die mit der Ladungsspeichervorrichtung verbunden ist, auf ein zweites Steuersignal anspricht, um einen Ladestrom der Ladungsspeichervorrichtung zuzuführen, so daß die Detektorvorspannung durch die Dauer des zweiten Steuersignals bestimmt wird; und

der Laserentfernungsmesser ferner eine Temperaturerfassungsschaltung (319) aufweist, die in der Nähe des Photodiodendetektors (CR1) angebracht ist, um die Temperatur in dieser Umgebung zu überwachen und ein die Temperatur anzeigendes Signal zu liefern.

2. Laserentfernungsmößvorrichtung nach Anspruch 1, ferner mit einem Transimpedanzverstärker (317), der einen Eingang, der mit dem zweiten Ausgangsanschluß verbunden ist, und einen Ausgang aufweist.

3. Laserentfernungsmößvorrichtung nach Anspruch 1, wobei die Stromquelle ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) einen ersten Feldeffekttransistor ( $Q_{b2}$ ) aufweist, der einen ersten mit einer Spannungsquelle verbundenen Anschluß aufweist, wobei der Feldeffekttransistor ( $Q_{b2}$ ) schaltbar ist, um den Ladestrom der Ladungsspeichervorrichtung (C1) zuzuführen.

4. Laserentfernungsmößvorrichtung nach Anspruch 3, wobei die Stromquelle ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) einen zweiten Feldeffekttransistor aufweist, der einen Gate-Anschluß, der zum Empfang des zweiten Steuersignals verbunden ist, und einen ersten Anschluß aufweist, der über einen Widerstand ( $R_{b3}$ ) mit dem Gate des ersten Feldeffekttransistors ( $Q_{b2}$ ) verbunden ist.

5. Laserentfernungsmößvorrichtung nach Anspruch 4, ferner mit einem dritten Feldeffekttransistor ( $Q_{b3}$ ), der ein Gate aufweist, wobei ein Inverter ( $A_{b3}$ ) einen mit dem Gate verbundenen Ausgang aufweist, wobei der Inverter einen Eingang besitzt, der verbunden ist, um das zweite Steuersignal zu empfangen, wobei der dritte Feldeffekttransistor ( $Q_{b3}$ ) ferner einen ersten mit der Anode der Diode ( $D_{b1}$ ) verbundenen Anschluß und einen mit Masse verbundenen zweiten Anschluß aufweist, wobei die Diode ( $D_{b1}$ ) ferner eine Kathode aufweist, die mit der Ladungsspeichervorrichtung (C1) verbunden ist.

6. Laserentfernungsmößvorrichtung nach Anspruch 1, ferner mit einer Überlastschuttschaltung, die eine Diode (CR3) aufweist, die mit dem Photodiodendetektor (CR1) und Masse verbunden ist.

7. Laserentfernungsmößvorrichtung nach Anspruch 1, wobei die Überlastschuttschaltung ferner ein Widerstands-Kondensatornetzwerk ( $R1$ ,  $C2$ ) aufweist, das eine Verbindung zu dem Photodiodendetektor (CR1) hat, um den Betrag der überschüssigen Ladung zu begrenzen, die durch die Diode (CR3) entladen werden kann.

8. Laserentfernungsmößvorrichtung nach Anspruch 2, wobei der Transimpedanzverstärker (317) an seinem Eingang auf einen Strom einen Strom-zu-Spannungs-Übertragungsfaktor anwendet, um eine Spannung an seinem Ausgang zu produzieren, die ein Vielfaches des Stroms ist.

9. Laserentfernungsmößvorrichtung nach Anspruch 8, wobei der Transimpedanzverstärker (317) einen Feldeffekttransistor (Q1) und einen ersten Widerstand (R6) aufweist und eine Leerlaufverstärkung besitzt, die durch einen Parameter "gm" des Feldeffekttransistors (Q1) bestimmt ist und durch einen Wert des ersten Widerstands (R6); und wobei der Wert des ersten Widerstands (R6) eingestellt wird, um Variationen des Parameters "gm" zu kompensieren, um eine gewünschte Leerlaufverstärkung aufrechtzuerhalten.

10. Laserentfernungsmößvorrichtung nach Anspruch 8, wobei der Transimpedanzverstärker (317) ferner einen Rückkopplungswiderstand (R5) besitzt, des-

sen Wert das Vielfache ist.

11. Laserentfernungsmessvorrichtung nach Anspruch 8, wobei der Rückkopplungswiderstand (R5) einstellbar ist, um die Bandbreite der Vorrichtung zu erhöhen.
12. Laserentfernungsmessvorrichtung nach Anspruch 1, wobei der Photodiodendetektor (CR1) eine Lawinenphotodiode aufweist.

## Revendications

1. Dispositif télémètre à laser, comprenant :
- un détecteur à photodiode (315) comportant une première borne et une seconde borne de sortie ;
- un dispositif d'accumulation de charge (C1) connecté à la première borne dudit détecteur à photodiode (315) destiné à accumuler une tension de polarisation de détecteur ;
- un premier circuit incluant un commutateur à transistor ( $Q_{b4}$ ) connecté audit dispositif d'accumulation de charge et sensible à un premier signal de commande pour décharger ledit dispositif d'accumulation de charge (C1) ;
- un second circuit destiné à charger ledit dispositif d'accumulation de charge ;
- caractérisé en ce que :**
- ledit second circuit comprend une source de courant ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ), connectée audit dispositif d'accumulation de charge, sensible à un second signal de commande pour appliquer un courant de charge audit dispositif d'accumulation de charge de sorte que ladite tension de polarisation de détecteur est déterminée par la durée dudit second signal de commande ; et
- le télémètre à laser comprend en outre un circuit de détection de température (319) monté à proximité dudit détecteur à photodiode (CR1) pour surveiller la température dans ledit voisinage et fournir un signal indicatif de celle-ci.
2. Dispositif télémètre à laser selon la revendication 1, incluant en outre un amplificateur d'adaptation d'impédance (317) comportant une entrée connectée à ladite seconde borne de sortie et une sortie.
3. Dispositif télémètre à laser selon la revendication 1, dans lequel ladite source de courant ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) inclut un premier transistor à effet de champ ( $Q_{b2}$ ) comportant une première borne connectée à une source de tension, ledit tran-

sistor à effet de champ ( $Q_{b2}$ ) pouvant commuter pour provoquer l'application dudit courant de charge audit dispositif d'accumulation de charge (C1).

4. Dispositif télémètre à laser selon la revendication 3, dans lequel ladite source de courant ( $R_{b1}$ ,  $Q_{b1}$ ,  $R_{b3}$ ,  $R_{b2}$ ,  $Z_{b1}$ ,  $Q_{b2}$ ,  $R_{b4}$ ) inclut un deuxième transistor à effet de champ comportant une borne de grille connectée pour recevoir ledit second signal de commande et une première borne connectée, par l'intermédiaire d'une résistance ( $R_{b3}$ ), à la grille dudit premier transistor à effet de champ ( $Q_{b2}$ ).
5. Dispositif télémètre à laser selon la revendication 4, incluant en outre un troisième transistor à effet de champ ( $Q_{b3}$ ) comportant une grille, un inverseur ( $A_{b3}$ ) comportant une sortie connectée à ladite grille, ledit inverseur comportant une entrée connectée pour recevoir ledit second signal de commande, ledit troisième transistor à effet de champ ( $Q_{b3}$ ) comportant en outre une première borne connectée à l'anode d'une diode ( $D_{b1}$ ) et une seconde borne connectée à la masse, ladite diode ( $D_{b1}$ ) comportant en outre une cathode connectée audit dispositif d'accumulation de charge (C1).
6. Dispositif télémètre à laser selon la revendication 1, incluant en outre un circuit de protection contre les surcharges incluant une diode (CR3) connectée audit détecteur à photodiode (CR1) et à la masse.
7. Dispositif télémètre à laser selon la revendication 1, dans lequel ledit circuit de protection contre les surcharges comprend en outre un réseau de résistance - capacité (R1, C2) comportant une connexion audit détecteur à photodiode (CR1) pour limiter la quantité de charge en excès qui peut être évacuée par ladite diode (CR3).
8. Dispositif télémètre à laser selon la revendication 2, dans lequel ledit amplificateur d'adaptation d'impédance (317) applique, au niveau de son entrée, un facteur de transfert d'intensité à tension à un courant, de façon à produire, au niveau de sa sortie, une tension qui est un multiple de ladite intensité.
9. Dispositif télémètre à laser selon la revendication 8, dans lequel ledit amplificateur d'adaptation d'impédance (317) inclut un transistor à effet de champ (Q1) et une première résistance (R6), et a un gain en boucle ouverte déterminé par un paramètre "gm" dudit transistor à effet de champ (Q1) et par la valeur de ladite première résistance (R6) ; et dans lequel la valeur de ladite première résistance (R6) est réglée pour compenser des variations du paramètre "gm" afin de maintenir un gain en boucle ouverte souhaité.

10. Dispositif télémètre à laser selon la revendication 8, dans lequel ledit amplificateur d'adaptation d'impédance (317) comprend en outre une résistance de contre-réaction (R5) dont la valeur est ledit multiple. 5
11. Dispositif télémètre à laser selon la revendication 8, dans lequel ladite résistance de contre-réaction (R5) peut être réglée pour augmenter la largeur de bande dudit dispositif. 10
12. Dispositif télémètre à laser selon la revendication 1, dans lequel ledit détecteur à photodiode (CR1) comprend une photodiode à avalanche. 15

20

25

30

35

40

45

50

55



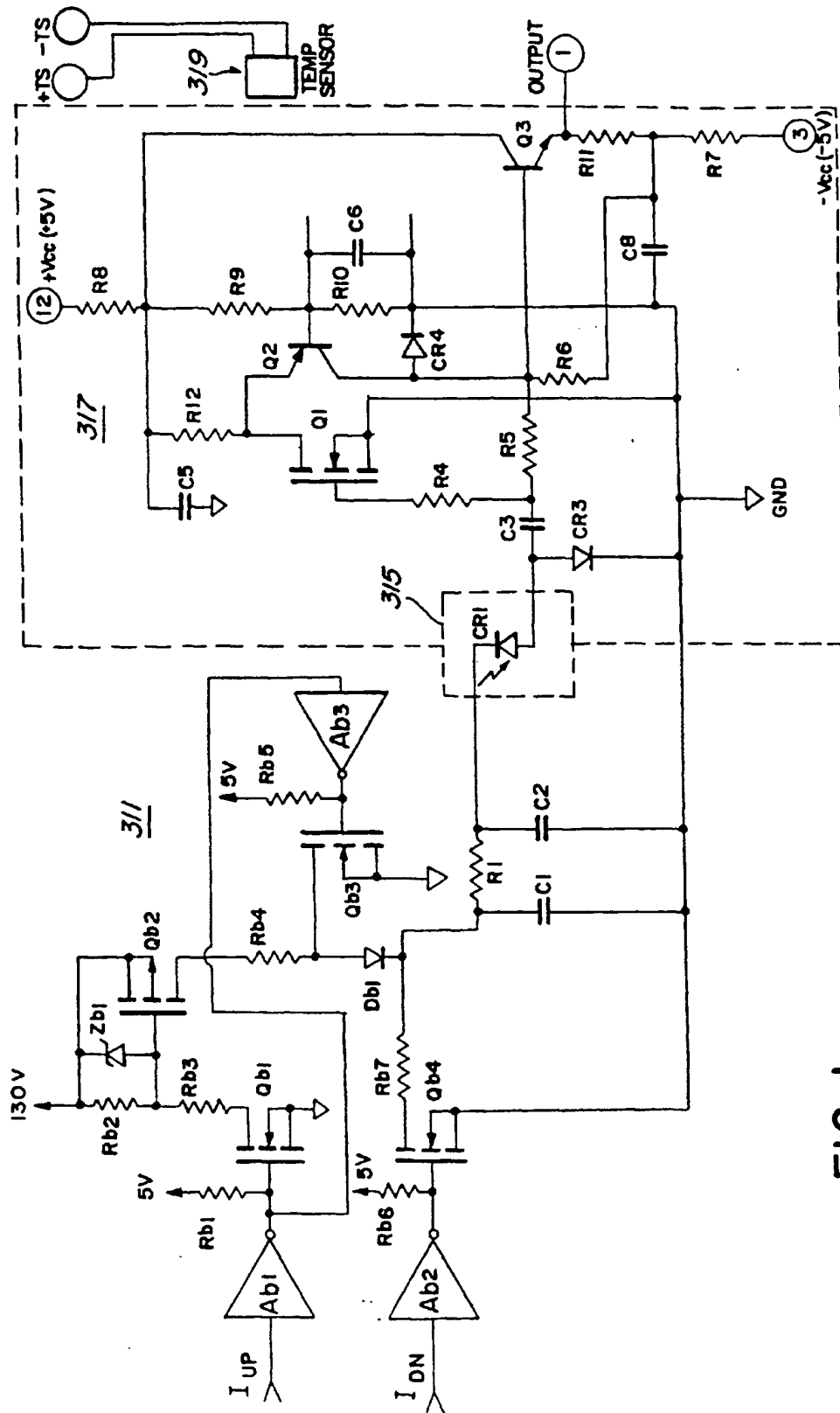


FIG. 1